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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/779,582 | 02/12/2004 | James G. Couillard | SP03-018 | 8926 |

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| EXAMINER | |
|---|---|
| SARKAR, ASOK K | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2891 | |

DATE MAILED: 02/01/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/779,582 | COUILLARD ET AL. | |
| | Examiner | Art Unit | |
| | Asok K. Sarkar | 2891 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *29 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *66-100 and 102-134* is/are pending in the application.

4a) Of the above claim(s) *66-96 and 113-128* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *97-100,102-112 and 129-134* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *07 July 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Response to Arguments*

1. Applicant's arguments with respect to claims 97 – 112 and 129 – 134 have been considered but are moot in view of the new ground(s) of rejection.

### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 97, 98, 102, 106 – 110, 112, 129 and 133 are rejected under 35 U.S.C. 103(a) as being unpatentable over Henley, US 6,010,579 in view of Stewart, US 6,610,582.

Regarding claims 97, 98, 108 – 110, 112, 129 and 133, Henley teaches a semiconductor – on – insulator layered structure comprising a substantially single – crystal semiconductor material (material S) (silicon wafer) and an oxide glass or an oxide glass-ceramic which comprises positive sodium ions (material G), wherein at least a part of the structure comprises in order:

- layer of material S, 2404; and
- layer of material G 2201, wherein the surface of material S, 2404 farthest from material G 2201 is an exfoliation surface with reference to **Fig. 12** and descriptions in between column 9, line 40 and column 13, line 15.

Henley teaches glass as a target wafer (column 10, line 64) and an electrostatic bonding process (column 11, lines 35 – 40) by applying voltage in column 13, lines 7 – 15 for the benefit of bonding two surfaces at a low temperature in column 11, lines 35 – 40. However, Henley fails to teach the consequences of the electrostatic bonding such as

- layer of material S with an enhanced oxygen content due to attachment of non – bridging oxygen atoms;

- layer of material G with a reduced positive ion concentration for at least one type of positive ion due to depletion of mobile sodium ions;
- material G with an enhanced positive ion concentration for at least one type of positive ion due to the migration away from the interface; and
- the material S and material S with an enhanced oxygen content is a first layer; the material G with a reduced positive ion concentration for at least one type of positive ion, the material G with an enhanced positive ion concentration for at least one type of positive ion, and the material G is a second layer; and the first and second layers are directly attached to one another as the final bonded structure in column 1, lines 30 – 43.

Stewart teaches electrostatic bonding between a sodium – containing glass and a silicon wafer in which layer of material S with an enhanced oxygen content due to attachment of non – bridging oxygen atoms; layer of material G with a reduced positive ion concentration for at least one type of positive ion due to depletion of mobile sodium ions; material G with an enhanced positive ion concentration for at least one type of positive ion due to the migration away from the interface; and the material S and material S with an enhanced oxygen content is a first layer; the material G with a reduced positive ion concentration for at least one type of positive ion, the material G with an enhanced positive ion concentration for at least one type of positive ion, and the material G is a second layer; and the first and second layers are directly attached to one another as the final bonded structure in column 1, lines 30 – 43 as a consequence of the electrostatic bonding process.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention that Henley's bonded structure between a sodium – containing glass and a silicon wafer will have material S with an enhanced oxygen content due to attachment of non – bridging oxygen atoms; layer of material G with a reduced positive ion concentration for at least one type of positive ion due to depletion of mobile sodium ions; material G with an enhanced positive ion concentration for at least one type of positive ion due to the migration away from the interface; and the material S and material S with an enhanced oxygen content is a first layer; the material G with a reduced positive ion concentration for at least one type of positive ion, the material G with an enhanced positive ion concentration for at least one type of positive ion, and the material G is a second layer; and the first and second layers are directly attached to one another as the final bonded structure as a consequence of the electrostatic bonding as taught by Stewart in column 1, lines 30 – 43.

Regarding claim 102, Henley in view of Stewart fails to teach the thickness of the semiconductor material.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control these parameters during the creation of SOI wafers between silicon wafer and glass by the anodic bonding and subsequent thinning process through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claim 106, Henley in view of Stewart fails to teach the oxide glass is transparent.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention that the glass is transparent since most ordinary alkali silicate glasses are inherently transparent.

Regarding claim 107, Stewart fails to teach that the SOI structure comprises an amorphous or polycrystalline semiconductor material and SiGe.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention that since the bonding is between silicon and glass, the semiconductor material can alternatively be amorphous or polycrystalline semiconductor material or SiGe material.

6. Claims 130, 131, 132 and 134 are rejected under 35 U.S.C. 103(a) as being unpatentable over Henley, US 6,010,579 in view of Stewart, US 6,610,582.

Henley in view of Stewart teaches the SOI structure where the semiconductor material has an enhanced oxygen content layer, the glass has a depleted as well as an enhanced positive ion material layer and these layers are created by the diffusion of

positive ions under the voltage applied by the two electrodes during the anodic bonding process.

However, Henley in view of Stewart fails to teach the thickness of the ion depletion region, that is parallel to surface of the semiconductor and glass materials and the relationship between the alkali/alkaline earth ion concentrations (claim 130 and 131), thickness of the oxygen enhanced region (claim 132) and the thickness of the bonded glass layer (claim 134).

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control these parameters during the creation of SOI wafers between silicon wafer and glass by the anodic bonding through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results. These parameters will depend on the particular semiconductor material , the glass used and the processing parameters such as time, temperature and voltage so that a final SOI wafer with adequate bond strength is produced satisfying the manufacturing goal.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

7. Claims 99, 104 and 105 are rejected under 35 U.S.C. 103(a) as being unpatentable over Henley, US 6,010,579 in view of Stewart, US 6,610,582 as applied to claim 97 above, and further in view of Spangler, US 5,343,064.

Regarding claim 99, Henley in view of Stewart teaches anodic or electrostatic bonding of alkali glass, but fails to teach glass wherein the at least one type of positive ion comprises an alkaline-earth ion.

Spangler teaches forming SOI structures by the same anodic bonding process in which the insulating glass is alkaline – earth glass in between column 14, line 64 and column 15, line 23 for the benefit of forming fully integrated SOI sensors in column 5, lines 1 – 13.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Henley in view of Stewart and use a glass wherein the at least one type of positive ion comprises an alkaline-earth ion for the benefit of forming fully integrated SOI sensors as taught by Spangler in column 5, lines 1 – 13.

Regarding claims 104 and 105, Henley in view of Stewart fails to teach the maximum dimension of S material layer and the total concentration of the alkali ions such as $Li^+$, $Na^+$ and $K^+$ ions.

Spangler teaches forming SOI structures by the same anodic bonding process in which he teaches forming a full sensor device on a single wafer in column 4, lines 61 – 68 and that alkali ion contamination is unwanted for semiconductor manufacturing and ways to prevent it in between columns 3 and 4 and specifically uses a special glass that

is free of alkali ions in between column 14, line 64 and column 15, line 23 for the benefit of forming fully integrated SOI sensors in column 5, lines 1 – 13.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Henley in view of Stewart and use a glass wherein the glass is alkali ions free so that the total alkali ion concentration is less than 0.1wt% for the benefit of forming fully integrated SOI sensors as taught by Spangler in column 5, lines 1 – 13. Moreover, with the thermal expansion matching, it would have been obvious to one with ordinary skill in the art at the time of the invention to implement the bonding process to silicon wafers that has maximum dimensions greater than 10cm.

8. Claims 100 and 111 are rejected under 35 U.S.C. 103(a) as being unpatentable over Henley, US 6,010,579 in view of Stewart, US 6,610,582 as applied to claim 97 above, and further in view of Spangler, US 5,343,064; Walker, US 6,825,909 and "Resistivity of Glass", http://hypertextbook.com/facts/2004/JaneGolubovskaya.shtml.

Both Steward and Spangler teach that for making SOI structures with glass the coefficient of thermal expansion of the glass should be matched with that of silicon and the glass is the insulator. Spangler also teaches that the strain point (similar to anneal point) is less than 1000°C in column 15, lines 1 – 5, but fail to teach oxide glass or oxide glass-ceramic has a 0 – 300°C coefficient of thermal expansion CTE and a 250°C resistivity ρ which satisfy the relationships:

$5 \times 10^{-7}/^{O}C <= CTE <= 75 \times 10^{-7}/^{O}C$ and $\rho < = 10^{16}\ \Omega - cm$.

It should be remembered that the coefficient of thermal expansion and the resistivity are inherent properties of the glass and Walker teaches that one such oxide glass has a 0 – 300$^{O}$C coefficient of thermal expansion CTE which satisfy the relationship: 5 X 10$^{-}$7/$^{O}$C <= CTE <= 75 X 10$^{-7}$/$^{O}$C in column 4, lines 60 – 67 and "Resistivity of Glass", http://hypertextbook.com/facts/2004/JaneGolubovskaya.shtml. teaches that glass has resistivity values that are < =10 $^{16}$ Ω – cm. The thermal expansion of the glass also satisfies the relationship: $CTE_1$ – 20 X 10$^{-}$7/oC <= $CTE_2$ <= $CTE_1$ + 20 X 10$^{-}$7/oC.

9. Claim 103 is rejected under 35 U.S.C. 103(a) as being unpatentable over Henley, US 6,010,579 in view of Stewart, US 6,610;582 as applied to claim 97 above, and further in view of Cho, US 2004/0020173.

Henley in view of Stewart fails to teach bond strength between material S and material G is at least 8 joules/meter$^2$.

Cho teaches that anodic bonding between glass and a semiconductor material can produce bond strength that is higher than the fracture strength of the glass materials that is inherently higher than 8 joules/meter$^2$ for the benefit of making it a high – yield process in paragraphs 9 and 53.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Henley in view of Stewart with that of Cho so that bond strength that is higher than the fracture strength of the glass materials for the benefit of making it a high – yield process as taught by Cho in paragraphs 9 and 53.

***Conclusion***

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William B. Baumeister can be reached on 571 272 1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

11. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Asok K. Sarkar
January 31, 2006

Primary Examiner